TRANSLATION

(19) Patent Office of Japan (JP)

(12) Gazette of Unexamined Patent Applications (A)

(11) Unexamined Patent Application Publication [Kokai] No.: P2002-155449

(43) Disclosure Date: May 31, 2002

(51) Int. Cl.[7]	Identification Symbol	FI		Subject Code (reference)
D03D 15/04	102	D03D 15/04	102A	3B011
A41D 13/00		A41D 13/00	G	4L036
31/00		31/00	C	4L041
	501		501E	4L048
	502		502B	
A41D 31/00	503	A41D 31/00	503C	
			503G	
D02G 3/04		D02G 3/04		
//D01F 8/14		D01F 8/14	B	

Request for Examination: not yet requested

Number of Claims: 4 OL (Total of 6 pages)

(21) Patent Application [Tokugan] No.: P2000-350665

(22) Filing Date: November 17, 2000

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F-terms (Ref.): 3B011 AA01 AB01 AC17
4L036 MA09 MA17 MA39 PA21 PA33 PA46 UA01
4L041 AA07 BA02 BA05 BA09 BB08 BC05 BC17 CA06 CA08 DD01 DD10
4L048 AA08 AA09 AA21 AA22 AA30 AA51 AB01 AB07 AB16 AC12 AC15 CA04 CA07 DA02 EB05

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(54) Title of the Invention: WOVEN FABRIC

(57) Summary

Object: To provide woven fabrics that are blends of polyester and plant-based fibers, which fabrics have a combination of stretch, a soft hand, excellent comfort when worn, dimensional stability and high dye fastness which is not attainable in the prior art.

Solution: A woven fabric composed of 20 to 90% (fabric weight basis) of bicomponent fibers made of two polyester-based polymers bonded in a side-by-side arrangement in the lengthwise direction of the fiber, wherein one of the components is a polyester that consists primarily of poly(trimethylene terephthalate), in admixture with plant-based fibers; which woven fabric has an average percent extension of at least 15% and an average percent recovery from extension of at least 70%.

SPECIFICATION

Claims

(1) A woven fabric comprising 20 to 90% (fabric weight basis) of bicomponent fibers made of two polyester-based polymers bonded in a side-by-side arrangement in the lengthwise direction of the fiber, wherein one of the components is a polyester that consists primarily of poly(trimethylene terephthalate), in admixture with plant-based fibers; which woven fabric has an average percent extension of at least 15% and an average percent recovery from extension of at least 70%.

(2) The woven fabric of claim 1, wherein the plant-based fiber is cotton.

(3) The woven fabric of claim 1 or 2, wherein the finished basis weight is at least 200 g/m^2.

(4) The woven fabric of claim 1, 2 or 3 for use in jeans or work clothing.

Detailed Description of the Invention

[0001]

Technical Field of the Invention:

The present invention relates to a plant-based fiber-containing woven fabric having a pleasant feel when worn, a high softness and a high stretch.

[0002]

Prior Art:

Woven fabrics made of plant-based fibers such as cotton and rayon are characterized by moisture absorption and a surface having a natural feel. Such fabrics are widely used in jeans and work clothing.

[0003]

However, for reasons particular to the fibers, these fabrics have a number of drawbacks, including a lack of stretch and a hard, stiff hand that detract from their desirability for wearing. Moreover, when laundered, they undergo a great deal of shrinkage, resulting in poor dimensional stability. In addition, they have a poor dye fastness, meaning that they lose color when laundered and stain white items in the same load.

[0004]

In view of the above, one conceivable solution is to blend elastomeric fibers such as polyurethane with the plant-based fibers so as to impart stretch. However, such fabrics are difficult to commercialize because polyurethane undergoes deterioration by chlorine in tap water and is also attacked by the reducing agents and alkalis used to bleach out color during the stone washing of apparel such as jeans.

[0005]

If a polyester is blended instead, chemical resistance ceases to be much of a problem, but the stretch properties which are essential leave something to be desired.

[0006]

For example, polyester false-twisted yarn has bulk, but its stretch properties are completely inadequate.

[0007]

Prior-art side-by-side bicomponent polyesters include the side-by-side bicomponent yarns composed of polyethylene terephthalates (abbreviated hereinafter as "PET") of differing intrinsic viscosity described in JP 44-2504 and JP-A 4-308271, and the side-by-side bicomponent fibers described in JP-A 5-295634 which are composed of a non-copolymeric PET in combination with copolymeric PET having higher stretch. Although yarn having some degree of stretch can be obtained by using such side-by-side bicomponent fibers, when these yarns are rendered into a woven fabric, the fabric has inadequate stretch, making it impossible to obtain woven fabric of sufficient stretch and also resulting in poor dimensional stability. The reason is that prior-art side-by-side bicomponent yarns have a low crimp developability when under constraint in a woven fabric or the crimps readily undergo permanent deformation when subjected to exterior forces.

[0008]

The stretch properties in such side-by-side bicomponent yarns are not attributable to stretch by the fibers themselves as in the case of polyurethane fibers. Rather, the stretch properties of such yarns relies on the stretch of three-dimensional coils that arises due to differential shrinkage between the constituent polymers. As a result, when the yarns are subjected to heat treatment while under constraint in a fabric that limits polymer shrinkage, the yarns become heat set in this state and lose the ability to shrink further, resulting in insufficient coil development and leading to the above problems.

[0009]

Problems to be Resolved by the Invention:

Accordingly, the object of this invention is to provide woven fabrics that are blends of polyester and plant-based fibers, which fabrics have a combination of stretch, a soft hand, excellent comfort when worn, dimensional stability and high dye fastness which is not attainable in the prior art.

[0010-0011]

Means for Resolving the Problems:

In order to resolve the above problems, the invention provides a woven fabric comprising 20 to 90% (fabric weight basis) of bicomponent fibers made of two polyester-based polymers bonded in a side-by-side arrangement in the lengthwise direction of the fiber, wherein one of the components is a polyester that consists primarily of poly(trimethylene terephthalate), in admixture with plant-based fibers; which woven fabric has an average percent extension of at least 15% and an average percent recovery from extension of at least 70%.

[0012]
Mode for Working the Invention:

Polyester-based side-by-side bicomponent fibers are used in at least the warp yarns or the filling yarns of the woven fabric according to the present invention.

[0013]

Side-by-side bicomponent fibers are obtained by bonding together polymers of differing intrinsic viscosity, copolymerization ingredients, copolymerization ratios and the like, and develop crimp owing to differences between their respective elastic recovery properties and shrinkage properties. In the case of side-by-side bicomponent yarns in which the constituent polymers having different intrinsic viscosities, stress concentrates on the high intrinsic viscosity side during spinning and drawing, resulting in differing internal strain between the two components. As a result, the high-viscosity side undergoes a large amount of shrinkage due to differences in the percent elastic recovery following extension and differences in heat shrinkage during heat treatment of the woven fabric, giving rise to strain within individual filaments that causes the filaments to crimp in the form of three-dimensional coils. The diameter of these three-dimensional coils and the number of coils per unit filament length is for the most part determined by the difference in shrinkage (including the difference in elastic recovery) between the high-shrinkage component and the low-shrinkage component. The larger the shrinkage difference, the smaller the coil diameter and the greater the number of coils per unit filament length.

[0014]

Coil crimping in a stretch material is required to have a small coil diameter, a larger number of coils per unit filament length (that is, excellent extension characteristics and a good appearance), and good permanent set resistance in the coils (low degree of permanent deformation by coils and excellent retention of stretch properties when subjected to repeated stretch), and a low hysteresis loss during recovery from extension by the coil (excellent resilience and a good sense of fit when worn). By satisfying these requirements while also retaining the properties of a polyester (i.e., suitable stiffness and drape properties, and a high dye fastness), there can be obtained a stretch fabric having an excellent overall balance of properties.

[0015]

Here, the properties of a high shrinkage component (high viscosity component) are required to satisfy the above-described coil characteristics. Because the shrinkage properties of the coils are governed by the stretch properties of the high-shrinkage component about the low-shrinkage component, the polymer used in the high-shrinkage component is required to have high extension and high recovery from extension.

[0016]

The inventors have conducted extensive investigations in order to satisfy the above properties without sacrificing the characteristics of the polyester. As a result, they have discovered the use of a polyester consisting primarily of poly(trimethylene terephthalate) (abbreviated hereinafter as "PTT") as the high-shrinkage component. PTT

fibers have an exception recovery from extension while retaining mechanical and chemical properties comparable with those of such typical polyester fibers as polyethylene terephthalate fibers and polybutylene terephthalate fibers. Apparently, this is because, in the crystalline structure of PTT, the gauche-gauche conformation of the methylene chains (the molecular chains are bent at 90 degrees) in the alkylene glycol portions of the molecule and the low density of points of constraint due to benzene ring interactions (stacking, lateral arrangement) provide a high flexibility which allows for easy extension and recovery of the molecular chain by rotation of the methylene groups.

[0017]

The PTT in the present invention is preferably a polyester in which the primary acid component is terephthalic acid and the primary glycol component is 1,3-propanediol. Other copolymerizable constituents capable of forming ester linkages may also be included in a proportion of preferably up to 20 mol %, and most preferably up to 10 mol %. Illustrative examples of such copolymerizable compounds include dicarboxylic acid compounds such as isophthalic acid, succinic acid, cyclohexanedicarboxylic acid, adipic acid, dimer acids, sebacic acid and 5-sodium sulfoisophthalic acid; and diols such as ethylene glycol, diethylene glycol, butanediol, neopentyl glycol, cyclohexanedimethanol, polyethylene glycol and polypropylene glycol. Other constituents that may be added if necessary include titanium dioxide as a delusterant, finely divided silica or alumina as a lubricant, hindered phenol derivatives as antioxidants, and color pigments.

[0018]

The low-shrinkage component (low-viscosity component) may be any fiber-forming polyester which has a good interfacial adhesion with the PTT serving as the high-shrinkage component and has stable yarnmaking properties. However, from the standpoint of mechanical characteristics, chemical characteristics, and raw material costs, the use of PET capable of being formed into fibers is preferred.

[0019]

For good yarnmaking properties and to achieve dimensional uniformity of the coils in the fiber length direction, it is advantageous for the two components to be used in relative proportions, expressed as the weight percent ratio of high-shrinkage component to low-shrinkage component, within a range of 72:25 to 35:65, and preferably 65:35 to 45:55.

[0020]

The side-by-side bicomponent fiber used in the invention may have a cross-sectional shape that is round, triangular, multi-lobed, flat, peanut-like, X-shaped or of any other irregular shape. For example, semicircular side-by-side fibers of round cross-section are desirable for a good balance of crimp developability and hand, hollow side-by-side fibers are desirable for light weight and heat insulation, and side-by-side fibers of triangular cross-sectional are desirable for a dry hand.

[0021]

The density per filament is preferably 1.1 to 10 dtex, and most preferably 1.1 to 6 dtex. At a density per filament of at least 1.1 dtex, stretch properties due to crimping can be achieved, and a density per filament of not more than 10 dtex enables puckering to be suppressed.

[0022]

In the practice of the invention, the use of such side-by-side bicomponent fibers in a substantially untwisted or soft twisted state is desirable from the standpoint of the stretch properties and the hand. "Substantially untwisted" refers to a soft twist of up to 500 turns/m, and preferably up to 300 turns/m, imparted to the warp yarns so as to improve the weaving properties.

[0023]

When an actual twist in excess of this is imparted, the smooth feel and soft hand are lost, and the hand becomes hard. Moreover, surface irregularities arise in the arrangement of single yarns, resulting in a loss of luster due to the backscattering of light by the surface irregularities.

[0024]

It is essential for the polyester-type stretch woven fabric of the invention to have a fabric percent extension in the longitudinal and/or transverse direction of at least 15%. The "fabric percent extension" is a stretch parameter defined under "Measurement Methods" in the Examples section of this specification. At a fabric percent extension of less than 15%, the fabric is unable to follow extension and contraction of the skin during movement by the body, making it impossible to obtain satisfactory comfort when worn. Moreover, the woven fabric of the invention must have a recovery from extension of at least 70%. At a fabric recovery from extension of less than 70%, the fabric does not recover when worn, causing sagging to occur at the knees and elbows and giving rise to wrinkling, which is undesirable. "Average percent extension" and "percent recovery," as used herein, refer to averages for the transverse and longitudinal directions of the fabric.

[0025]

The blending ratio of the side-by-side bicomponent fibers and plant-based fibers according to the invention is such that the side-by-side bicomponent fibers have a weight ratio in the fabric weight of 20 to 90%. For reasons having to do with stretch and dye fastness, admixture of the side-by-side bicomponent fibers within a range of 30 to 80% is especially preferred. At less than 20%, the stretch and dimensional stability are poor, whereas at more than 90%, moisture absorption and surface changes in the plant-based fibers become inadequate. Neither condition is desirable.

[0026]

No particular limitation is imposed on the method of blending the bicomponent fibers and plant-based fibers. However, to maximize the effects of the invention, it is preferable to use either a method in which the two fibers are woven separately into the

fabric and the bicomponent fibers which serve as the warp and/or filling yarns are incorporated with no twist or a soft twist; or a method in which the bicomponent fibers are doubled and twisted together with cotton yarns. If the former approach is used, it is especially preferable for the bicomponent fibers and the plant-based fiber to be woven in alternation as the warp yarns and filling yarns because this further increases the dimensional stability of the fabric. If the latter approach is used, aside from simply doubling and twisting together the bicomponent fibers and the plant-based fibers, another efficient and desirable method is a core spinning process in which the two types of fibers are combined by spinning together the bicomponent fibers as the core yarn and the plant-based fibers as the sheath yarn.

[0027]

The woven fabric in the invention has a finished basis weight of at least 200 g/m^2, and is advantageous for use in jeans and work clothing because of its excellent strength, fit and functionality. A finished basis weight of 250 to 500 g/m^2 is especially preferred. At less than 200 g/m^2, the fabric is thin and flimsy, which may make it unsuitable for such applications. On the other hand, at more than 500 g/m^2, the fabric is thick and heavy, which is generally undesirable.

[0028]

Accordingly, in light of the above, the woven fabric of the invention exhibits the best effects when used in such items of apparel as jeans, slacks and skirts, and in outerwear such as work clothing and uniforms.

[0029]

"Plant-based fibers," as used herein, refers to regenerated fibers and semi-synthetic fibers obtained from plants or using plants as the raw material. Specific examples include vegetable fibers such as cotton and linen; regenerated fibers such as viscose rayon, cuprammonium rayon, Tencel, Lyocell and modal; and semi-synthetic fibers such as acetate and triacetate.

[0030]

Looms that may be used to obtain the woven fabric of the invention are not subject to any particular limitation. For example, an air jet loom or a rapier loom may be used.

[0031]

It is advantageous to use as the warp yarns or filling yarns a blended yarn composed of bicomponent filament yarn in combination with plant-based fibers (staple yarn) which has, depending on the above basis weight, a total denier of 220 to 550 dtex.

[0032]

For reasons having to do with stretch and softness, the woven fabric most preferably has a serge construction, although advantageous use can also be made of a plain or a rib weave.

[0033]

After being woven, the fabric is typically subjected to relaxation heat treatment, intermediate set, dyeing and finishing. In relaxation heat treatment, for crimping of the side-by-side bicomponent fibers to overcome the constraining forces of the woven fabric and undergo a sufficient degree of development, it is preferable that the liquid temperature to be set to at least 80°C. The use of a disperse dye on the polyester side and of an indigo dye or a reactive dye on the cotton side is preferable because the dye fastness can be further increased. In the case of jeans, treatment in which the dyed fabric, after it has been sewn into jeans, is subjected to partial decomposition of the adsorbed dye in a stone washer to create a faded sensation is desirable because it improves the surface feel of the fabric.

[0034]

The resulting woven fabric which is made of a combination of polyester and plant-based fibers has stretch, a soft feel, a functionality that includes excellent comfort when worn, and moreover exhibits dimensional stability and excellent dye fastness.

[0035-0037]
Examples:

Examples are given below by way of illustration. The evaluation methods used in the examples are described below.

Evaluation Methods

(1) Average Percent Extension of Woven Fabric:

Measurements were obtained by method A (constant rate of extension method) for measuring percent extension in JIS L-1096. A higher value indicates greater stretch properties and is desirable. The average percent extension was arrived at by adding together respective percent extension values in the longitudinal direction and the transverse direction of the fabric, and taking one-half of the sum.

(2) Average Percent Recovery from Extension:

Measurements were obtained by method A (constant rate of extension method) for measuring percent recovery from extension in JIS L-1096. A higher value indicates greater stretch properties and is desirable. The average percent recovery from extension was arrived at by adding together respective percent recovery from extension values in the longitudinal direction and the transverse direction of the fabric, and taking one-half of the sum.

(3) Softness:

The fabric obtained after the completion of dyeing was held in the hands and subjected to sensory evaluation by a panel of ten judges. One of the following three ratings was assigned.

Good: Excellent softness
Fair: Softness is comparable to that of ordinary woven fabric
Poor: No softness

(4) Dimensional Stability:

The percent dimensional change in the dyed woven fabric when laundered was determined according to method G in JIS-1042. A smaller value indicates less change in dimension and is desirable. A percent change in dimension of 2.5% or less is generally desirable.

(5) Dye Fastness:

The dye fastness of the dyed woven fabric was rated on the following scale of 1 to 5 according to JIS-L-0844.

5: Excellent (no staining or bleeding)
4: Good
3: Fair
2: Poor (some staining and bleeding)
1: Very poor

Working Example 1

Yarnmaking:

Homo-PTT having an intrinsic viscosity (IV) of 1.40 and homo-PET having an intrinsic viscosity (IV) of 0.60 were each separately melted, then spun together in a compounding ratio (wt %) of 50:50 from a 24-hole spinneret for spinning bicomponent fibers at a spinning temperature of 275°C, and hauled off at a spinning speed of 1,400 m/min, giving unstretched 495-dtex, 24-filament bicomponent yarn having a side-by-side arrangement. In addition, using a hot roll/hot plate-type drawing machine (yarn contacting length, 20 cm; surface roughness, 3S), drawing was carried out at a hot roll temperature of 75°C, a hot plate temperature of 170°C and a draw ratio of 3.3. Instead of being hauled off, the yarn was then subjected to relaxation at a ratio of 0.9 and wound up, giving a 165-dtex, 24-filament drawn yarn.

[0038]

During both spinning and drawing, the yarnmaking properties were good; no yarn breakage arose.

Weaving:

Both the warp yarns and the filling yarns were prepared in the same way. Two of the side-by-side bicomponent filament yarns were twisted together at 100 t/m and used together as a 330 dtex yarn, to which was then twisted a strand of 30s cotton yarn. The resulting combination yarn was woven into a 2/2 twill design at a warp by weft density in the greige fabric of 88×73 yarns/2.54 cm on a rapier loom. The basis weight of the woven fabric was 33 g/m^2.

[0039]

The fiber blending ratio, expressed as the ratio of PTT/PET in the side-by-side bicomponent fibers to the cotton, was 23%/23%/54%.

Dyeing and Finishing:

The resulting greige fabric was relaxation heat treated and dried at 95°C in an open soaper, then intermediate set under dry heating at 180°C and dyed with a blue disperse dye and indigo dye in two baths at 130°C and 98°C. Next, the fabric was finish set by a pin tenter process under dry heat at 170°C. The finished roll had a warp by weft density of 112×95 yarns/2.54 cm. The finished basis weight was 413 g/m^2.

<u>Comparative Example 1</u>

A finished woven fabric was produced as in Working Example 1, except that a 100% polyester 165-dtex, 24-filament false-twisted yarn was doubled and twisted with the cotton yarn. The blending ratio, expressed as the ratio PET/cotton, was 46%/54%.

<u>Comparative Example 2</u>

A finished woven fabric was produced as in Working Example 1, except that a 100% poly(trimethylene terephthalate) (PTT) 165-dtex, 24-filament false-twisted yarn was doubled and twisted with the cotton yarn. The blending ratio, expressed as the ratio PTT/cotton, was 46%/54%.

Evaluation Results:

The woven fabric obtained in Working Example 1 had an average percent extension of 22% (warp direction, 21%; filling direction, 23%) and an average percent recovery from extension of 89% (warp direction, 85%; filling direction, 92%), and thus exhibited excellent stretch properties. Moreover, the fabric had a very soft hand (softness rating: Good), dimensional stability (warp direction, 0.3%; filling direction, 0.2%), and a high dye fastness (ratings for color fading, staining and bleeding were all 4 or 5)

[0040]

The average percent extension for the fabric obtained in Comparative Example 1 was 3.3% (3.0% in warp direction, 3.5% in filling direction), which was entirely unsatisfactory.

[0041]

The average percent extension for the fabric obtained in Comparative Example 2 was 8.8% (8.4% in warp direction, 9.1% in filling direction), and the average percent recovery from extension was 40% (43% in warp direction, and 37% in filling direction). Both these values were unacceptably low.

[0042]

The fabric obtained in Working Example 1 was sewn into jeans and subjected to stone washing treatment. The resulting jeans were worn for an extended period of time, in the course of which, as with the woven fabric ratings, they exhibited excellent comfort, high physical properties and high fastness.

Working Example 2

The same side-by-side bicomponent fibers as in Working Example 1 and 20s cotton yarn were woven in alternation, both as the wrap yarns and the filling yarns, in a plain weave design to form a combination fabric. The fabric was woven to a greige fabric density, expressed as the warp by weft density, of 72×67 yarns/2.54 cm, on an air jet loom. The fiber blending ratio, expressed as the ratio of PTT/PET in the side-by-side bicomponent fibers to the cotton, was 18%/18%/64%.

[0043]

The resulting greige fabric was dyed under the same conditions as in Working Example 1 (but to a black color). The finished roll had a warp by weft density of 94×87 yarns/2.54 cm. The finished basis weight was 372 g/m^2.

[0044]

The woven fabric obtained in Working Example 2 had an average percent extension of 26% (warp direction, 26%; filling direction, 25%) and an average percent recovery from extension of 90% (warp direction, 88%; filling direction, 92%). Moreover, the fabric had a very soft hand (softness rating: Good), dimensional stability (warp direction, 0.4%; filling direction, 0.3%), and a high dye fastness (ratings for color fading, staining and bleeding were all 4 or better).

Working Example 3

A woven fabric was produced as in Working Example 1 using the same side-by-side bicomponent fibers as in Working Example 1, but using 30s Tencel (a regenerated fiber) instead of cotton. The fiber blending ratio, expressed as the ratio of PTT/PET to Tencel was 21%/21%/58%.

[0045]

The resulting greige fabric was dyed under the same conditions as in Working Example 1. The finished roll had a warp by weft density of 92×86 yarns/2.54 cm. The finished basis weight was 376 g/m^2.

[0046]

The woven fabric obtained in Working Example 3 had an average percent extension of 22% (warp direction, 20%; filling direction, 24%) and an average percent recovery from extension of 89% (warp direction, 87%; filling direction, 91%). Moreover, the fabric had a very soft hand (softness rating: Good), dimensional stability (warp direction, 0.2%; filling direction, 0.2%), and a high dye fastness (ratings for color fading, staining and bleeding were all 4 or 5).

[0047]

The fabric obtained in Working Example 3 was sewn into work clothing, and worn for an extended period of time, in the course of which, as with the woven fabric ratings, they exhibited excellent comfort, high physical properties and high fastness.

[0048]
Advantages of the Invention:

The present invention provides woven fabrics that are blends of polyester and plant-based fibers, which fabrics have a combination of stretch, a soft hand, excellent comfort when worn, dimensional stability and high dye fastness which is not attainable in the prior art.

Translation: Language Services
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July 10, 2003